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# Evaluation of the impact of access to electricity: A comparative analysis of South Africa, China, India and Brazil

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ABSTRACT

Most developing countries include rural electrification programs in their efforts to improve social conditions. There are, however, several obstacles to the evaluation of such programs and therefore of their social, economic, environmental and energy impacts on the target population, particularly on impoverished communities located in remote areas. Evaluation of the efficacy of public policies aimed at rural electrification in South Africa, China, India and Brazil enables such actions to be quantified and re-considered so as to bolster the sustainability of their planning and implementation and also so as to enable comprehension of the significance of access to electricity in relation to other aspects of the drive to improve living standards. The provision of electric energy amounts to more than access to a public service and should be considered an essential right, in a context of social equity and justice, which permits social integration and the access to other equally essential services.



**Contents**



## 1. Introduction

Drawing up and implementing evaluation systems for public policy is an integral part of the re-structuring of the role of the State, and is significant aspect of changes in political and administrative culture that result from restructuring processes. They are relevant, however, only to the extent to which they play an important role part in the adoption of new styles of public management, which are result-oriented, socially controlled, managed in accor-

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dance with effectiveness criteria,[1] being aimed at equity in the social distribution of the benefits of government policy [1].

The International Energy Agency [2] estimated that, in 2008, over 1.5 billion people had no access to electricity. Rural populations accounted for 85% of this total, with the majority located in remote areas of developing countries.

There has been a move in recent years towards expanding the supply of electricity to rural areas as part of the drive to stimulate the economic and social development of the target populations, particularly in countries such as South Africa, China, India and Brazil. Evaluation of the efficacy of public policies aimed at rural electrification enables such actions to be quantified and, if necessary, re-considered so as to bolster the sustainability of the planning operations and also so as to enable comprehension of the role of access to electricity in relation to other aspects of the drive to improve living standards. The provision of electric energy amounts to more than access to a public service and should be considered an essential right, in a context of social equity and justice, which permits social integration and the accessibility of other equally essential services.

This document is divided into 5 sections. Section 2 presents the topic addressed in the paper and the context in which it arises. In Section 3 we highlight the methodological aspects of evaluating public policies. In Section 4 we present the Rural Electrification governmental programs examined and their respective results in South Africa, China, India and Brazil. Finally in Section 5 we set out conclusions and recommendations.

## 2. The context of the evaluation of impacts

Evaluation should be regarded as an integral stage of the process, so that it may lead to the creation of new policies (i.e. re-consideration of the policies initially presented) or may be used as a guide in the implementation of such policies. An evaluation usually leads to the making of decisions and is an important source of information for policy formulation. In recent years the literature has emphasized the political aspects of an evaluation process inserted into the implementation stage, the focus being realistic and positive, rather than negative and utopist with the prevailing view being that the political sphere interacts with questions relating to the construction (selection) of that which should be evaluated. This does not amount to intervention as such but rather to 'political space' in the implementation of policies.[2]

The activity of evaluation is not isolated and self-sufficient. It is one of the stages in the process of planning governmental policies and programs: it generates information which enables new choices to be made; the analysis of results may give rise to the realignment of actions in order to achieve the stated aims.

The growing interest of governments in evaluation studies is related to the efficacy, efficiency and performance of public management, in that such studies provide a tool for the formulators, implementers and managers of public policies and programs.[3]

Derlien [3] identified three functions attributed to the evaluation of policies, namely: information, allocation and legitimation. For Ala-Harja and Helgason [4], the evaluation of programs is a mechanism for the improvement of the decision making process. Although it is not in itself aimed at resolving or substituting subjective judgments, the evaluation permits a decision-maker to be aware of the results of a given program, with said information thereby enabling her/him to improve the concept or implementation of the program, drawing on the information for future decisions or so as to improve the provision of accounts in respect of public policies and programs.

The effect of the access to electricity by the poorest segments of the population is one of the main interests of recent literature in relation to electrification programs. In countries where a large proportion of the population is impoverished, such as South Africa, where 40% of the population is considered poor, it is necessary, to the extent possible, to analyze electrification programs separately in terms of the provision of access to poor and non-poor groups, and the respective impacts. Policies which are structured to improve the welfare of the population may frequently not be effective for the poorest segments, which may require subsidies whilst other segments might be assisted by other mechanisms which are less onerous in terms of government expenditure.

## 3. Methodological aspects of the evaluation of impact

The human thirst for knowledge is directly linked to the need to understand, explain, judge and alter reality. Natural human curiosity directs thinking towards a value judgment. Thus the evaluation or judgment is intrinsically related to the development of human knowledge. Evaluation is basically a value judgment – the attribution of a value [5].

The development of evaluative research reflects not only the importance of the evaluation as a means of judging processes of actions but also as a means of producing knowledge.

There is currently in Brazil a broad variety of concepts and approaches to the monitoring and evaluation of government planning and management. No consolidated approach has, as yet, emerged. The evaluation of government programs to date has been characterized by uncoordinated and interrupted attempts, the results of which have only rarely been documented and systematized [6]. This is largely due to the dominant characteristics of government planning in the country: the emphasis on the process of formulation of projects and the general disregard of the monitoring and evaluation of processes, results and impacts.

The combination of these two characteristics strongly limits the potential for analysis of whether or not the objectives stated during the formulation of the program were actually attained during its implementation. At the same time, it restricts awareness of how the program functions and the causes of the success or failure to attain the desired goals.

[1] Evaluation of the efficiency of a program is, by its very nature, an evaluation of the process. Efficiency relates to the qualities of a program, examined in the light of technical parameters of time and cost. In accordance with a relatively restricted definition it can be seen as the relationship between products (goods and services) and the costs of the resources (raw materials and activities) in the light of a given norm or parameter. Examples of this in the context of rural electrification are connection cost per unit (R$/unit), and connection cost per km (R$/km). The concept of efficacy refers to the objectives and targets, on the one hand and the impact and effects on the other. The efficacy of a program is measured by the rate and quality at which the specific objectives are attained, i.e. the changes envisaged in the reality to which the program is applied. The indicators used to measure the efficacy of a given program very frequently include the degree of satisfaction of the users or interested groups.

[2] The technocratic strategy of eliminating or insulating public policy from the wider political sphere has proved to be unrealistic and undemocratic. Unrealistic because all government action or intervention by means of programs and projects is essentially political: it distributes costs and benefits and makes use of collective resources. The strategy of insulation would appear not to be viable in a democracy, in that it restricts participation, information and social control.

[3] Note that a social program or social intervention are characterized as a planned and organized effort aimed at attenuating or improving social conditions judged to be unsatisfactory.

**Table 1**
Types of approaches in the evaluation of social programs.

| Types of approach | Evaluation methodologies | Data gathering | Role of the evaluator |
|---|---|---|---|
| Quantitative/experimental: centered on the action system | • Methodologies supported by statistics and controlled experiments | • Emphasis on instruments of quantitative measurement | • External evaluation |
| | • Hypothetical deductive explanatory scheme | • Definition of result indicators | • Expert evaluator |
| Quantitative/naturalist: Centered on the logic of the actors | • Methodologies supported by analysis of social processes | • Emphasis on the gathering of qualitative data via participative observation, life stories or reports, analysis of content, non-directive interviews, case studies, self-assessment | • Subject inserted into the evaluative process |
| | • Research action | • Observation and description of significant facts | • Role of facilitator viz à vizthe subjects involved |
| | • Schematic interpretation of dynamics | | |
| Pluralist: centered on the relations between the system of action and the logic of the actors | • Methodologies of evaluation of programmed change (public policies or programs) | • Emphasis on the gathering of qualitative and quantitative data | • Co-evaluation between categories of imp Heated actors |
| | • Plurality of approaches so as to comprehend and verify processes, results and the impacts of policies and programs | • Definition of indicators of the process and of results | • Role of coordinator, facilitator and/or consultant in the evaluation |
| | | • Use of various instruments for the gathering of data, including observation | |

There are several alternative means of evaluating a program.[4] The choice of evaluating approach[5] is the result of an interactive process between the evaluator and the main players interested in the evaluation. The process can be difficult, because deciding what is to be evaluated also involves deciding what will be set apart. Different types of evaluation respond to different questions, and focus on different issues and variables [5].

The evaluation of social programs has been set up and undertaken in various way by different evaluators. Specialists in evaluation have sought adjectives to indicate in concrete terms the type of evaluation that is being undertaken. One classic distinction observed in the literature is that between summative and formative evaluation. The first seeks to conclude whether or not an existing social program produces the desired effect. The second addresses a program which is underway with the aim of fine-tuning its development. A summative evaluation seeks to answer the question: does the program attain its objectives? The formative evaluation, on the other hand, seeks to answer the question: *in what ways can the program be improved?*

We set out, in Table 1 an overview of the types of program evaluations and their respective approaches. The experimental approach uses quantitative methods, guided by objectivity and directed towards the verification and confirmation of hypotheses (hypothetical-deductive). It is assumed in this approach that reality is stable. The naturalist approach uses qualitative methods, guided by subjectivity and is directed towards the discovery of hypotheses (exploratory/inductive/descriptive). The naturalist approach assumes that reality is dynamic. The pluralist approach makes use of both qualitative and quantitative data, and is based on the definition of indicators of the process and of results so as to ascertain and gauge processes, results and the impacts of policies and programs.

Evaluating social impacts is a considerably ambitious task bearing in mind the inherent complexity of the so-called social-phenomena, which are regulated by limited, relative, varied and partial determinisms. An evaluation is a powerful instrument with which to learn about the social reality being studied, with all the imperfections and risks inherent to working with a reality that is undergoing constant change, influenced by various agents.

## 4. Evaluation of the impacts of rural electrification programs

The energy question is at the forefront of the issues facing developing countries. The need to expand the electricity supply as part of the drive towards energy inclusion and the positive collateral effects of access to electricity raises a need to evaluate the true contribution made by public authorities in the efforts to reduce poverty and increase social inclusion. Tackling poverty requires a range of public policies, aimed both at mitigation and at eradication.

We chose four countries in order to evaluate the context, objectives, approaches and results of rural electrification: South Africa, China, India and Brazil, and highlighted various stages of the implementation of policies in each country. We based our selection of countries on the fact that they share common economic, social and energy characteristics, namely: a major and on-going social deficit; a large contingent of people without regular access to electricity in a safe and secure manner. Fig. 1 sets out the geographical location of the 4 countries in question.

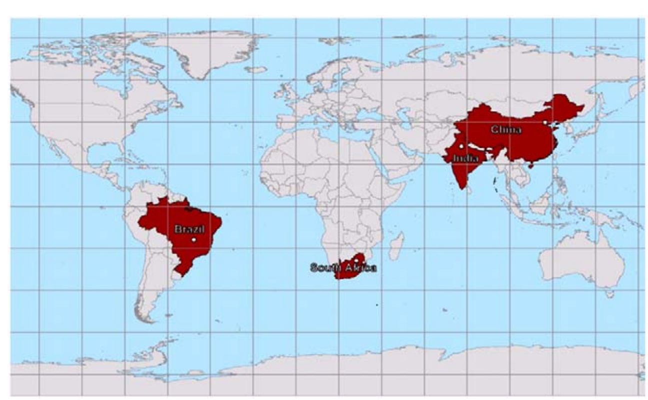



**Fig. 1.** Geographical location of the countries.

[4] Different authors group the "types" of evaluation according to different standpoints and criteria. There is no consensus as to typology or classification. Markedly different views are commonplace, which makes it difficult to summarize or even fully grasp this "multiplicity" of evaluations.

[5] The current trend is to combine qualitative and quantitative approaches in the evaluation of social programs.

South Africa has a population of 48 million people, in an area of 1.2 million km$^2$, and is Africa's most industrialized country, with a GDP of US$ 495 billion [2], according to the purchasing power parity (PPP) method. It is wealthy in natural reserves which include coal, gold and diamonds. The economy is highly energy-intensive by African standards, and the country has the continent's highest per capita consumption of energy, due to the presence of its mining industry. The country underwent profound change in 1994, with democratic elections that led to a new direction being taken in almost all aspect of government, affecting the population as a whole. Despite recent advances the country continues to have strong disparity in terms of income levels and racial groups, and there are still significant differences in the extent and manner in which basic public services are provided to ethnic groups. The per capita income of US$ 10,344 is close to the world average, nevertheless 50% of the population lives below the poverty line, indicating a clear concentration of income, as is confirmed by a Gini Coefficient of 0.65. Further, even though the country has the one of the highest electrification rates in Africa, 1/4 of the population does not have regular access to electricity. Only 55% of the rural population has access to electric energy.

China is a country of continental dimensions with a population of 1.3 billion people in an area of 9.6 million km$^2$, governed by a non-democratic, central planning regime which is moving towards a market economy. It has experienced high economic growth over the past 20 years, and in 2008 its GDP was US$ 7903 billion (PPP) [2]. Despite having the world's second largest GDP, after the USA, its income[6] per capita is approximately half the world average of US$ 10,000.

Even though China has considerably reduced the number of poor people,[7] the rate of economic growth in the country has been unequal, particularly as between the urban and rural areas. This is one of the current concerns of the Chinese government in its pursuit of economic growth and the amplification of basic services. Despite the strong growth in the last few decades the rural population of approximately 900 million still faces major obstacles in breaking the cycle of poverty, particularly in the Western Region of China. In percentage terms, the population without access to electricity is relatively small, nevertheless totaling, in absolute numbers, 10 million people in 2008, with the major challenge being supplying electricity in a sustainable manner to this segment of the population, 55% of which live in remote rural areas, which are less economically dynamic, and who therefore have lower income.

India is a country of great social and economic contrast, with 300 million people living below the poverty line, in a territory of 3.3 million km$^2$. 1/3 of the population does not have access to electricity on a regular basis, this amount, in real terms, to 376 million people, despite strong economic growth over the past 10 years. Given the conditions of extreme poverty of the population, together with the insufficiency of the supply of energy from modern sources, the population is extremely dependent on the use of biomass, and cooking accounts for 90% of the demand for energy amongst poor people. Note, further that India has the highest share of the world's annual consumption of biomass – 22% – significantly higher than that of the other continental-size countries with similar social inequality. Furthermore, until recently, the indicator of electrification in India was not based on the percentage of the population or dwellings with access to electricity but rather on the extent of the distribution networks for a given area. From this viewpoint, 86% of the towns and villages had access to electric energy. This interpretation was modified in 2004, so that the rate of supply was calculated in terms of provision of electricity per domicile and/or per head of population.

Even though India has one of the world's largest GDPs, reaching US$ 4024 trillion (PPP) in 2008 [2], its per capita income remains approximately 1/3 of the world average. 39% of the population is illiterate and 70.8% reside in rural areas.

Brazil is continental in size, having an area of 8.5 million km$^2$, and a population of 191 million. It is democratically run and is the most industrialized and diversified country in Latin America, with a GDP of US$ 1.9 billion (PPP). It possesses great potential in terms of exploration and use of natural resources, including renewable energy, and a burgeoning export-led agricultural industry.

Despite this major economic and energy potential and notwithstanding the fact that it had one of the world's highest economic growth rates in the 20th century, Brazil is still characterized by marked social contrasts, with 39 million people living below the poverty line [2]. Whilst economic growth has led to some improvement in living standards, it is also the case that the lower rate of growth over the last two decades led to a concentration of income, reaching a Gini Coefficient of 56.7. In addition there is a significant disparity in the provision of public services between urban and rural areas, and the absence of regular access to electricity is an obstacle to the improvement of the quality of life of rural dwellers, particularly those living in the Northern and North-Eastern regions of the country.

In the following analysis drawn from international experience in evaluating rural electrification programs, we shall emphasize the use of the summative evaluation,[8] which is a methodological option, generally applied to long-term programs with a view to studying their efficacy and describing their benefits. At the same time we give priority to studies that apply a more contemporary approach, seeking to evaluate all stages of the project and, where possible, comparing them, without, therefore, limiting analysis to the ex-post phase.[9]

### 4.1. Impact evaluation in South Africa

When the democratic government of South Africa was elected in 1994 it was noted that a significant proportion of the population lacked access to such basic services as water, electricity adequate health care and education. Concomitantly, there were considerable limitations on the public resources available for investment in such services. The political and social policies of the new South Africa were drawn up via the Reconstruction and Development Program – RDP) which set out ambitious targets for the expansion of basic services, to be heavily subsidized by the State. The government view was that the provision of basic infrastructure, including electricity, was essential in order to promote social welfare and thereby catalyze economic development.

The RDP sought, amongst other things, to accelerate the National Electrification Program (NEP).[10] The government sought, in thefirst

[6] By way of illustration, countries such as Qatar and Zimbabwe are at opposite ends of the scale: the first ahs a per capita income of US$80.900 the second US$200.

[7] The number of poor people declined from 260 million in 1978 to 30 million in 2001, with rural electrification being one of the key elements in economic development and reduction of poverty in China [7].

[8] The literature indicates that the *summative* and *formative* approaches may be combined, thus enabling better comprehension of the reality being studied, as well as the inner workings of the decision-making and implementation processes. Note however that this combination is not always possible when, for instance, the agents implementing a project and those evaluating it have different interests and objectives.

[9] The traditional evaluation which limits analysis to the *ex-post*, phase makes it more difficult to interpret the results in that it is difficult to distinguish a poorly constructed project from a project which is basically sound but is being poorly implemented.

[10] This effort was in fact part of the continuation of the *Electricity for All Program* launched in 1991. In 1994 the new government launched a fresh program – the *National Electrification Program (NEP).*

phase of the program (1994–1999) to effect 450,000 connections per year, 300,000 of which via the national Eskom concessionaire with the remaining 150,000 to be effected by municipal concessionaires.

This ambitions program was launched in 1994 with a target of electrification of 2.5 million homes in five years. Between 1994 and 1999 the program targeted the homes of low income groups which lacked access to electricity, both in rural and urban areas. Historically, whilst the white minority relied almost exclusively on electricity to supply its basic energy needs the black majority used lower quality and less convenient fuels such as firewood, paraffin, battery-power and candles [8].

In fact this Program established an international precedent, in that the rate of electrification achieved was one of the highest in the world. Significantly, unlike many other major electrification programs in developing countries, this result was attained without external financing [8].

Evaluation of the first phase of the National Electrification Program (NEP) fell to the Government Department of Minerals and Energy, to be completed prior to the implementation of the second phase. The Ministry hired a team from the University of Cape Town's Energy and Development Research Center (EDRC), under the supervision of the Development Bank of Southern Africa.

8 provinces were included in the sample analyzed, covering 430,000 dwellings – approximately 17% of the total electrified under the NEP. The evaluation was, however, heavily reliant on data provided by the concessionaires, and the methodology proved problematic due in part to time constraints and also the non-availability of data. In several areas the evaluation was limited to financial issues.

According to the Department of Mines and Energy [8] none of the programs formally addressed environmental issues. This is frequently the case with electrification programs which do not, generally speaking, make specific provision for environmental impacts. It is generally considered that electrification improves the quality of air in enclosed spaces and reduces deforestation by reducing the need for firewood.

Although environmental issues were not formally evaluated, the records of informal conversations with members of newly electrified communities reveal a general perception in such communities that electricity provides many benefits, including safe illumination of enclosed as well as the reduction of pollution inside dwellings. Researchers further noted a reduction, following the provision of electricity, in the gathering and burning of firewood, and a consequent reduction the other hand, the use of such fuels for certain purposes e.g. cooking persisted, even following the introduction of electricity.

In relation to the consumption of electricity[11] it was noted that the recently electrified dwellings consumed considerably less energy than anticipated, thereby limiting the return on the investment made by the distributors. The figures showed an average consumption in the provinces of around 100 kWh/month, with the province of Mpumalanga (TED) having the highest rate of 190 kWh/month, and the Northern Province (Nprov) at the other end of the scale has 62 kWh/month (Table 2).

One possible explanation for the low rate of consumption is the high rate of non-technical losses (NTL). This is particularly true for locations and periods of acute social issues, such as increased unemployment.

In relation to economic issues, the average connection charge[12] was calculated as R 3213 with a negative Net Present Value of – R 1.023. According to Eskom, the country's main concessionaire, supplying electricity to low-income groups is not financially viable. In order to become viable, the consumption needs to reach 350 kWh/month for 20 years. Even though the Program was only launched in 1994, its natural consumption rate could more realistically be expected to be around 150 kWh/month, albeit that some households consume well under 100 kWh/month.

The major challenge for the government is to provide universal access but there remains an unresolved issue in terms of the energy policy–the question is not whether it is necessary to subsidize the provision of electricity to poorer groups but rather, how, and how soon such subsidy can be arranged [9].

According to the Department of Minerals and Energy [8], the evaluation of the first phase of the NEP encountered a significant lack of data. However, in the view of the Department this lack of data did not limit the lessons learned from the project's evaluation. The South African government is currently aiming to attain universalization of access to electricity by 2012. To this end between 2 and 3 million dwellings are to be provided with electricity by means of solar panels. The standard model of panel used (50 Wp) is designed to generate sufficient power for 3–4 light bulbs, a radio and a TV [10].

Davis [11], states that people's choice of the energy they use results form a range of factors including the number of residents in the dwelling, the area in which it is located, the climate, cultural factors and the cost of the various energy alternatives. These variables, and others, impact on the speed with which electricity is incorporated into the energy basket. Having undertaken a comparative study in South Africa between rural dwellings that had been electrified and those which had not, Davis concluded that in fact electricity was seen as one more energy option, and did not exclude the other options, which were still utilized. This was particularly clear in the middle and lower income households studied by the author. He noted, however, that electricity was assuming an increasingly important role in cooking, gradually substituting firewood and kerosene particularly in higher income homes.[13]

Table 3 sets out an overview of the National Electrification Program of the Government of South Africa in the 1994–99 period and its evaluation. In relation to the lessons learned it is interesting to note that the first phase of the NEP exceeded its targets, despite the fact that the program underwent decentralization and further in spite of the fact that its was not relying on international loans. It was concluded that the program improved the well-being of the families benefitted, albeit that the benefits were limited almost exclusively to lighting. At the same time the reduction in the risk of fire caused by the use of paraffin or candles was noted, as well as the reduction of domestic pollution when electricity was used for heating and cooking. The benefits in terms of well-being were fewer than envisaged at the outset of the program, and the consumption of electricity lower than expected.

The electrification program in South Africa was implemented in an attempt to achieve three distinct objectives. The initial aim was economic, then came the socio-economic goal, followed more recently by the social aim. Different solutions are however necessary to attain different objectives. In some cases the change in objectives and the related processes were not explicit, in that the regulatory structure, which was maintained, had been established on the basis of strictly economic criteria [13].

[11] The projections were made for a 20 year horizon from 1994, based on an annual rate of growth in urban demand of 6%, and 3% in rural areas. These figures were adjusted in line with the experience of distributors. Note that growth in consumption is related to the economic conditions of the location amongst other factors. Furthermore, specific projects may vary and may not be easily generalized.

[12] The Exchange rate in 1999 (June) was R5.9 to US$ 1 [12].

[13] According to Davis [11], the perception that recently electrified domiciles only use electricity for lighting and information (radio and TV) is a clear and gross oversimplification.

**Table 2**
Monthly consumption of electricity per province and projections.

| | NW Prov (Mmabatho) | N Prov (Venda) | W Cape (Khayelitsha) | N Cape (Kimberley) | Kz/Natal (Durban) | Gauteng (Orange Farm) | TED (Mpumalanga) | E Cape (KwaNobuhle) |
|---|---|---|---|---|---|---|---|---|
| Av kWh/month (or 2000 | 127 kWh | 62 kWh (20A) | 116 kWh | 134 kWh | 155 kWh | 80 kWh | 190 kWh | 165 kWh |
| Av kWh/month – 20 year projection | 193 kWh | 96 kWh (20A) | 246 kWh | 204 kWh | 330 kWh | 171 kWh | 211 kWh | 165 kWh |

Source: DME [8].

**Table 3**
Summary of the evaluation.

| Program | Period | Cost | Central aim of the program | Results of the program | Beneficiary | Expected result of the evaluation | Methodology |
|---|---|---|---|---|---|---|---|
| National Electrification Program | 1994–99 | R8 billion (1) | 2.5 million domiciles | 2.7 million domiciles, 1344 rural schools and 495 clinics | Low income and urban population | Set out the lessons learned during the first phase so as a basis for the second phase of the program (universalization) | Ex-post |

| Sample | Information gathering method | Control | The evaluation – context | Results of the evaluation |
|---|---|---|---|---|
| 430.000 | Data supplied by the concessionaires | Not used | The evaluation was heavily based on the analysis of financial questions. The manner in which data was obtained was problematic, and restricted the extent of the analysis. Some analysis was carried out by means of conversations and the individual reports of the operational agents of the concessionaires involved. | Improvement in people's quality of life, arising mainly from lighting and reduction of exposure to pollution in enclosed spaces. In economic terms the projects were not viable, albeit that the calculations did not include social and environmental factors. |

Source: Drawn up by the authors.

### *4.2. Evaluation of impacts in China*

Rural electrification in China has been expanding rapidly since 1949, making a significant contribution to the growth and development of the agricultural sector, the rural economy and the quality of life of the rural population. Past efforts enabled over 900 million people to access electricity in rural areas in the last 50 years, so that the country attained an overall electrification rate of 98% [14].

Despite being tightly controlled by the State, which implements a strict family planning policy, China has a current rural population of around 800 million, which accounts for 70% of the total population. Most of this population has low-income and lives in isolated settings in regions where there is strong pressure on local energy resources. At the same time recent years have witnessed an aggravation of the social contrasts between urban and rural areas. Per capita income in the countryside increased 23% from RMB[14] 1926.07 (Yuan) in 1996 to 2366.40 in 2001, whereas the corresponding increase in urban areas was 42%, from RMB 4838.9 to RMB 6859.6.

The increase in the gap in wealth between urban and rural residents is a source of major concern to the Chinese government. The rural population of around 800 million has a share in the overall GDP of only 16%. The country's rulers have been seeking ways of reducing the contrast, with the provision of electricity, on an uninterrupted basis to this segment of the population, being one of the cornerstones of energy planning for rural areas.

The share of non-commercial sources of energy in the total energy consumed by the rural population in China has decreased significantly from 80% to 33%. They remain the principal sources of energy for cooking and heating however, and the environmental problems caused by their use persist [15].

In recent years over RMB 300 billion has been invested in the expansion and improvement of access to electricity. Nevertheless the infra-structure available to rural dwellers continues to be inadequate, requiring further large-scale investment, particularly in relation to those living in isolated areas.

Between 1988 and 1997 the Chinese government made a concerted effort to promote rural electrification.[15] O Estado, as owner of energy companies, implemented a range of policies designed to stimulate rural development via access to electricity. Specific projects including those named: Serving Agriculture – Serving Peasants; Serving Rural Economic Development; A Project to Reduce Poverty and Simultaneously Enrich Rural and Urban Households at the Same Time by Electrification. Other more recent programs include the Brightness Program and Developing Rural Power through Wind, both launched in 1996.

The main problems identified by the government in meeting the demand for electricity in rural areas included: obsolete equipment and concerns about safety in relation to supply; a poorly planned and constructed network, with an inefficient layout, low quality of equipment and processes and significant losses; fragmented management of the system and conflicts of interests between the agents; high tariffs for final consumers, acting as a disincentive to consumption [16].

The 1996 Brightness Program sought to improve the living conditions of populations located in remote areas by means of sup-

[14] The Exchange rate in July 2001 was RMB 8.26 to US$ 1 [12].

[15] In 1998 consumption in rural China was 495.5 TWh, 41% of national consumption [16]. 20% of this energy was locally generated, principally in Small Hydroelectric Plants (45%) and coal based thermal plants 50% [15].

plying electricity from decentralized sources. The target was to supply 23 million people using solar and wind power, with an average capacity of 100 W per capita, attaining an additional installed capacity of 2.300 MW. A major proportion of the target population was trapped in the poverty cycle. The Brightness Program was therefore a large-scale project aimed at reducing poverty, based on substantial investment. Initial estimates set at RMB 10 million the amount to be invested in equipment and services in order to meet the Program's targets. The project was focused on provinces in the West of China, particularly Xinjiang, Inner Mongolia, Gansu, Qinghai and Tibet (Fig. 1). Further investment was planned, in tandem with the program, in roads, railway stations, oil pipelines and other infrastructure. The program was coordinated by the State Development Planning Commission (SDPC) between 1996 and 1999.

A specific project (case study) was designed to evaluate the impact of the arrival of electricity on people's day to day life, particularly in terms of economic and social issues. Said project was developed in conjunction with Chinese institutions with financing for local training of operators and technical staff provided by Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) the German government's Technical Cooperation Agency (GTZ), with the support of the KfW Bankengruppe the German state owned social development bank (KfW).[16]

Table 4 sets out an overview of information pertaining to the evaluation of the impact of the Chinese government's efforts to broaden access to electricity, in particular by means of renewable sources in the Western region and its effects in terms of improving the quality of life of the target populations.

The evaluation project used a Baseline Survey (BLS) – field research undertaken prior to the intervention – and a Final Investigation (FI) – field-research carried out afterwards.[17] The project was launched in 2002 and the Baseline Surveys were undertaken in the same year in Yunnan, and in 2005 in the Qinghai and Gansu provinces. The Final Investigation was carried out in 2007.

The sample groups were as follows: 560 dwellings from Qinghai, 470 dwellings from Yunnan and 800 from Gansu. Said dwellings were provided with permanent access to electricity, benefitting 7900 people. In Qinghai, the energy was supplied via installed systems of photovoltaic panels and diesel generators, with average consumption per dwelling of 16.44 kWh, at a monthly cost per dwelling of RMB 42.[18] In the Yunnan province 17 systems (also consisting of photovoltaic panels and diesel generators) were installed, with an average consumption per dwelling of 28.5 kWh, at a monthly household cost of RMB 14.5. Finally, in the Gansu province, 18 such systems were installed, together with a further 7 systems of photovoltaic panels only, with an average consumption per dwelling of 9 kWh, and an average monthly household cost of RMB 11.

Electricity was distributed to the surveyed regions by means of mini-networks, with the aim of supplying the villages, particularly those where the hybrid system of photovoltaic panels and diesel generators was used.

One of the effects noted of the replacement of "other sources of energy" by electricity was the reduction of pollution inside the dwellings as a result of the reduction in the use of candles and kerosene. There was also a reduction in environmental damage caused by the disposal of batteries, with this effect being particularly noticeable in the provinces of Gansu and Yannan.

Table 5 sets out information about the changes in the expenditure on energy following the arrival of regular (permanent) electricity supply. A significant reduction in expenditure on candles was noted in the provinces of Qinghai and Yunnan, whilst the reduction was much lower in Gansu. In aggregate terms, the overall results clearly demonstrate the need to reflect on the policy of energy supply, particularly in terms of the need to ally access to electricity with prices/tariffs that enable continuity of use by the target populations. In Qinghai, for example, overall expenditure on energy increased by 88% following the arrival of electricity, whilst in Yunnan it fell by 76%.

It was noted in the Final Investigation that 15% of the families researched stated that they use electricity for productive purposes. The researchers noted the existence of restaurants and small retail stores,[19] and the use of energy for the commercial processing of wood and cutting of grass was also observed.

According to Hölzer and Huba [19], the number of electric home appliances owned and used provides an important indication of the degree of electrification and the awareness of the "new" users as to the possible utilization of electric energy. It is also possible, using this information, to draw conclusions as to the economic situation of the families. It was noted that, in the provinces researched, electrification led to a leap in the acquisition of electric home appliances soon after the systems were installed. In the Gansu province 93% of the households researched purchased a TV. In Qinghai 95% of the households acquired electric appliances: VCRs, TVs, washing machines, refrigerators and rice machines. In the Yunnan province around 97% of all households purchased electric home appliances: VCRs, TVs, washing machines and rice machines.

It was noted at the outset of the research that none of the residents had free (leisure) time, whereas during the later stage of the research it was recorded that 100% of those interviewed now had some free time during each day or week. This fact arose out of access to electricity, with watching TV being a typical manner in which to spend their free time. An additional benefit of this was access to media of information and weather reporting, with such access having a positive impact on the living conditions of the target population.

The links between energy and health are complex. Two aspects are however worthy of note: firstly, it was observed that with the advent of regular access to electricity and the consequent use of electric home appliances that enabled improved hygiene in the preparation and refrigerated storage of food, there was a concomitant improvement in the standard of living of the members of the household. Secondly, health service providers were able to store medication in refrigerated conditions.

China brought about accelerated growth in the improvement of the living standards of its population, due, in part to the major drive by the government to electrify rural areas. In 1950, 40% of the rural population had access to electricity, whilst by 2004 the total had reached 95%. There are, however, approximately 9 million people in remote areas of the country who still do not have regular access [20]. Further, there is still a need for electrification to be accompanied by a series of economic, social and environmental programs to promote and improve transport, agricultural activity, credit, education and health, which are equally important [15].

[16] One of the challenges faced by those responsible for the evaluation was the need for extreme caution in publishing results that might be seen as less than positive for the projects being examined. Chung [17] states that culture and politics in China do not encourage transparency. Political sensitivities surrounding the projects may lead to clouding of the findings of otherwise well-intentioned evaluation and monitoring. Governments are frequently disinclined to permit independent evaluation which may publish findings that are not in accord with official policy. This is particularly true of dictatorial regimes such as China. Evaluation instruments are also extremely sensitive to political changes. Baker [18] lists three impact studies that were canceled due to Chinese regime change.

[17] The author carried out a periodical survey, but the focus of this present study will be on results arising between the two extremes.

[18] The Exchange rate in 2007 (July) was RMB 7.57 to US$ 1 [12].

[19] In which electricity is used mainly for lighting.

**Table 4**
Summary of the evaluation.

| Country profile | Program | Period | Cost | Central aim of the program | Results of the program | Beneficiary | Expected result of the evaluation |
|---|---|---|---|---|---|---|---|
| China | Brightness program | 2001–05 | RMB 10 billion | 23 million people | Phase 1:1780 million dwellings and 2000 villages | Low income rural population, principally in the Western Region | Evaluating the impact on the day to day life of the target population of the arrival of electricity |

| Methodology | Sample | Means of gathering information | Control | The evaluation – context | Results of the evaluation |
|---|---|---|---|---|---|
| Ex-ante, ex-post and pilot | 1870 (non-experimental) | Field research, interviews and focal groups | Used | The evaluation sought to adopt a multi-disciplinary approach. The means of gathering data was well planned, using a pilot. The lack of democratic openness leads to some restrictions in terms of interpreting the results of the evaluation | Improvement in the quality of life of the target population, arising principally from the acquisition of electronic home appliances and increased leisure time. |

Source: the authors.

**Table 5**
Alterations in expenditure on sources of energy in the provinces.

| | | Gansu | Qinghai | Yunnan |
|---|---|---|---|---|
| Candle (a) | BS | 20 | 24 | 68 |
| | IM | 16 | 3 | 0.1 |
| | Difference | −4 | −21 | −67.9 |
| Battery (b) | BS | 1.4 | 1.1 | 3.3 |
| | IM | 0.8 | 2.2 | 2.2 |
| | Difference | −0.60 | 1.10 | −1.10 |
| Kerosene (b) | BS | 7.5 | | |
| | IM | 1.5 | | |
| | Difference | −6 | d | d |
| Electric Energy (c) | IM | 11 | 42 | 14.2 |
| Cost of lighting and communication | BS | 28.9 | 25.1 | 71.3 |
| | IM | 29.3 | 47.2 | 16.8 |
| | Difference | 0.4 | 22.1 | −54.5 |
| | Difference | 1% | 88% | −76% |

Source: Drawn up on the basis of Hölzer and Huba [19].
*Notes*: (a) 1 RMB per unit, (b) 1.1 RMB per unit, (c) 5 RMB per liter and (d) Kerosene is not relevant in these provinces.

### *4.3. The evaluation of impacts in India*

In India, access to modern sources of energy, in particular for use in cooking, is severely limited in rural areas. This is a common problem which is independent of the income levels of the affected groups, and which afflicts even the largest (wealthiest) states. All income groups resort to traditional sources of energy, due in part to cultural preferences and cheap or free availability as well as to the limited access to regular electricity and the unreliability of the system. Associated with this are the harmful effects on the health of the population. According to the World Bank [21], the use of traditional energy sources in India for cooking leads to the death of 500,000 people annually and 500 million cases of emission related illness.

Providing almost 600 million people with access to energy is a major challenge particularly when 124 million of the target households are located in rural areas. Firewood is the principal fuel used for cooking in these households. In rural areas 90% of households depend on traditional sources of energy for their cooking needs. Biomass accounts for 84% of the energy basket of such households. This is a clear indication of the level of energy poverty in India[20] given that the literature on the theme of energy and development holds that that the greater the dependence of the population on traditional sources of energy, the poorer said population is considered to be, bearing in mind that there are many facets to poverty other than those pertaining merely to income.

Kerosene and electricity are the principal forms of energy used for lighting in India. 78 million households in rural areas use only kerosene. Access to modern sources of energy is extremely limited in the rural areas, with significant health related social costs, particularly for women and children, who are more vulnerable to the harmful effects of the burning both of biomass and kerosene.

The Indian government launched an ambitious project aimed at electrifying 100% of the villages by 2007, and providing universal access by 2012. According to the World Bank [22] the total investment necessary is US$ 95 billion, including the cost of overhauling the existing system and expanding generation. Significant investment is needed in order to extend the grid and in order to improve rural infrastructure.

The deadline for electrifying the villages was extended to 2008, with plans to electrify 110,000 villages. 92,000 villages were to be included in an expanded network, with a further 18,000 villages, located in arid or mountainous areas or on riverbanks, being supplied by means of off-grid solutions. In recent years, in fact, the expansion of access has progressed at a rate of 2500 villages per year, so that it is unlikely that the target will be met by the forecast deadline.

Table 6 provides an overview of the process of evaluation of the impact of the efforts of the Indian government to broaden access to electricity in rural areas, in particular in terms of the daily life of women in six states and the improvement in the quality of life of the people studied. Note that the evaluation was not part of a

[20] Over 70% of households in India use solid combustible fuel, principally biomass, such as firewood or dung. They also use coke and coal for their primary cooking needs. [21].

**Table 6**
Summary of the evaluation.

| Country | Program | Period | Cost | Central aim of the program | Results of the program |
|---|---|---|---|---|---|
| India | – | 1996 | – | – | – |

| Expected result of the evaluation | Methodology | Sample | Method of gathering information | Control |
|---|---|---|---|---|
| Evaluation of the impact of the arrival of electricity in the day to day life of women | Ex-post | 5 (experimental) | Field research and interviews | Used |

Source: Drawn up by the authors.

**Table 7**
Acquisition of electric home appliances by rural households (%).

| Electrical appliances (%) | With electricity | Without electricity |
|---|---|---|
| Lamps/light bulbs | 100 | 0 |
| Kerosene lamps | 43 | 55 |
| TV | 41 | 0 |
| Ventilators (electric fans) | 41 | 0 |
| Clothes iron | 37 | 0 |
| Radio | 36 | 5 |
| Transistor | 19 | 28 |
| Refrigerator | 7 | 0 |
| Mixer | 7 | 0 |
| Electric oven/stove | 2 | 0 |

Source: Drawn up on the basis of the ESMAP [23].

specific program for the electrification of rural areas, so that complementary data as to costs, objectives, etc. were not available.

We set out below, with a view to demonstrating the results of the efforts of public authorities in India to electrify rural areas in an attempt to reduce the social inequality endemic to the country, a study undertaken by the World Bank together with an Indian institution, the Operations Research Group (ORG). The field research was carried out in 1996, surveyed over 5.000 households[21] in 180 villages in six Indian states: Maharashtra, Andhra Pradesh, Punjab, Himachal Pradesh, West Bengal and Rajasthan. The aim of studying six states[22] was to cover the socio-economic and cultural diversity of the country, in that the regions selected are representative of the various climates, topography, agricultural production and rural economy of India. The distinguishing feature of the World Bank study was its examination of the impact of rural electrification on the lives of women.

Consumption of electric energy and electric home appliances is strongly related to income and low income levels in rural India mean that electricity is used relatively infrequently in comparison with the urban areas. Table 7 sets out in percentage terms the extent to which the population acquired home appliances following electrification and shows that 41% of newly electrified households acquired TVs, 37% acquired electric irons and 41% acquired ventilating fans (this being a commonly acquired product in countries such as India which are subject to very high temperatures) (Table 8).

The World Bank (ESMAP) report [23] found that women in households with regular access to electricity have an improved work-leisure balance, in that they spend less time (compared with non-electrified households) gathering fuel and water and cooking.

One of the most interesting results of the survey was the information on the time women dedicated to reading (Table 9). According to the World Bank ESMAP report [23] field research showed that the amount of time dedicated to reading by women who had no access to electricity was very similar. On the other hand, the time dedicated to reading by those with access to electricity increased significantly in all income groups. It was noted, furthermore, that women in low-income groups with access to electricity had a less onerous life (in terms of physical work) than those in the same income bracket who did not have access.

Rural electrification has a significant impact on the lives of women, particularly in terms of reduction of tiring manual work and increase in the time available for reading and watching TV. A rural electrification program with an emphasis on the reliable supply of electricity is therefore justified on the basis of the improvement in the quality of life of women, and such a program aims further to accelerate the process of reduction of social inequality, particularly when accompanied by official efforts to promote education, to provide credit for small-scale purchases (electric home and rural appliances) and improvement in the design and operation of traditional ovens (chulhas), so as to reduce the consumption of firewood and the emission of pollutants.

In relation to the effects of the level of education on the quality of life of the women it is possible to note, on the basis of the information set out in Table 10 that, generally, those who have access to electricity on a regular basis have a greater balance between work and leisure and spend less time on the more physically arduous daily tasks. The time dedicated to gathering fuel decreases inversely to the level of education but independently of educational level women with access to electricity, as might be expected, have to spend less time gathering firewood than those who do not have access.

The reliability of the system is one of the main concerns in rural electrification, bearing in mind that the benefits of electricity are considerably limited when there are recurrent power cuts. Only 4% of households surveyed reported no blackouts per month whilst 40% reported 1 to 10 blackouts per month and 11% reported 91 to 300 blackouts per month. This data clearly indicates the low reliability of the system which explains and validates the use of kerosene as backup for lighting.

Finally the ESMAP report [23] states that cultural issues should not be overlooked in terms of improving the development and implementation of the electrification program. For example the subordinate role of women in the rural areas should be borne in mind in terms of the implementation of the findings of several studies that indicate that the consultation and participation of potential

**Table 8**
Average allocation of the time of women (hours per day).

| Activities | Without electricity | With electricity (and TV) |
|---|---|---|
| Gathering of fuel | 0.90 | 0.32 |
| Fetching water | 1.00 | 0.71 |
| Cooking | 2.93 | 2.53 |
| Reading | 0.03 | 0.32 |
| Watching TV | 0.06 | 1.63 |
| Leisure (other) | 10.49 | 10.42 |

Source: Drawn up on the basis of the ESMAP [23].

[21] The households surveyed in India are composed, on average, of 5.92 people.
[22] Note that historically the states of the northeastern region are more conservative in terms of the position of women in society than southern states.

**Table 9**
Allocation of the time of women in relation to their income bracket (hours per day).

| Income bracket (without electricity) | Gathering fuel | Fetching water | Cooking | Reading | Watching TV | Leisure (others) |
|---|---|---|---|---|---|---|
| <9000 | 1.07 | 1.02 | 2.75 | 0.04 | 0.06 | 10.49 |
| 9001–18,000 | 0.82 | 0.95 | 3.04 | 0.02 | 0.05 | 10.50 |
| 18,001–32,000 | 0.89 | 1.03 | 3.04 | 0.05 | 0.04 | 10.52 |
| 32,001–42,000 | 0.63 | 2.00 | 3.07 | 0.05 | 0.19 | 10.67 |
| 42,001–60,000 | 0.76 | 0.0 | 2.69 | 0.02 | 0.11 | 10.37 |
| >60,000 | 0.95 | 1.19 | 2.61 | 0.01 | 0.08 | 10.31 |
| **Income bracket (with electricity)** | **Gathering fuel** | **Fetching water** | **Cooking** | **Reading** | **Watching TV** | **Leisure (others)** |
| <9000 | 0.68 | 1.03 | 2.56 | 0.10 | 0.32 | 10.65 |
| 9001–18,000 | 0.61 | 0.92 | 2.62 | 0.15 | 0.48 | 10.45 |
| 18,001–32,000 | 0.55 | 0.86 | 2.60 | 0.19 | 0.79 | 10.39 |
| 32,001–42,000 | 0.40 | 0.82 | 2.58 | 0.26 | 1.02 | 10.57 |
| 42,001–60,000 | 0.37 | 0.76 | 2.51 | 0.31 | 1.23 | 10.52 |
| >60,000 | 0.37 | 0.81 | 2.54 | 0.30 | 1.13 | 10.31 |

Source: Drawn up on the basis of the World Bank ESMAP report [23].

**Table 10**
Allocation of the time of women in accordance with their educational level (hours per day).

| Educational level (without electricity) | Gathering fuel | Fetching water | Cooking | Reading | Watching TV | Leisure (others) |
|---|---|---|---|---|---|---|
| Illiterate | 1.11 | 10 | 2.60 | 0.01 | 0.03 | 10.29 |
| Literate | 0.51 | 0.81 | 3.15 | 0.0 | 0.03 | 10.34 |
| Primary (1–4 years schooling) | 0.93 | 0.930 | 3.04 | 0.01 | 1.03 | 10.46 |
| Intermediate (5–7) | 0.97 | 1.06 | 2.92 | 0.03 | 0.04 | 10.52 |
| Advanced (8–10) | 0.80 | 1.04 | 3.02 | 0.06 | 0.09 | 10.53 |
| Secondary (11–12) | 0.77 | 1.17 | 2.95 | 0.05 | 0.07 | 11.04 |
| Graduation and above | 0.52 | 0.88 | 3.13 | 0.16 | 0.24 | 10.54 |
| **Educational level (with electricity)** | **Gathering fuel** | **Fetching water** | **Cooking** | **Reading** | **Watching TV** | **Leisure (others)** |
| Illiterate | 1.00 | 1.04 | 2.22 | 0.07 | 0.34 | 10.59 |
| Literate | 0.70 | 0.93 | 2.36 | 0.12 | 0.45 | 10.52 |
| Primary (1–4 years schooling) | 0.79 | 0.95 | 2.63 | 0.06 | 0.27 | 10.30 |
| Intermediate (5–7) | 0.63 | 0.96 | 2.50 | 0.07 | 0.44 | 10.40 |
| Advanced (8–10) | 0.52 | 0.90 | 2.66 | 0.17 | 0.67 | 10.44 |
| Secondary (11–12) | 0.43 | 0.80 | 2.58 | 0.25 | 1.01 | 10.51 |
| Graduate level and above | 0.33 | 0.79 | 2.59 | 0.38 | 1.19 | 10.51 |
| Technical | 0.07 | 0.78 | 2.85 | 0.43 | 1.13 | 10.60 |

Source: Drawn up on the basis of the ESMAP [23].

beneficiaries tend to lead to the more promising outcome to the projects.

### 4.4. The evaluation of impacts in Brazil

The year 2003 saw the implementation of a new model in the national electricity sector, distinct principally in terms of the participation of the private sector in the planning and universalization of access. At the end of 2003, the federal government launched the "Light for All" (*Luz para Todos)* universalization program, with the aim of supplying electricity to 10 million people by 2008. This deadline was subsequently extended to 2010.

The Light for All program sought to provide universal access to electricity within seven years, in line with an established chronogram. Previous legislation already required the electric energy concessionaires to electrify by 2015 all households in Brazil that did not have access to electricity.

The "Light for All" program is the largest rural electrification program implemented in Brazil, and draws on means of provision other than extension of the distribution system, such as: Decentralized Generation Systems with Isolated Networks and Individual Generation Systems.

According to the Ministry of Mines and Energy [24], the initial target of 10 million people was attained in May 2009. The target was then revised upwards to incorporate fresh requests with the new total set at 14,829.940. By February 2010, 11,399,370 people throughout Brazilian territory had been benefitted by the program at an investment of R$ 16,461,225,440.00.[23]

The evaluation of the "Light for All" program seeks to ascertain the impacts of the program on the target population and the reported degree of satisfaction. Table 11 sets out an overview of the evaluation in the context of the efforts of the Brazilian government to increase access to electricity in rural areas.

The Ministry of Mines and Energy (MME) worked in conjunction with a Brazilian company, Zaytecbrasil Serviços de Pesquisa Ltda, to draw up the evaluation. The results were published in 2009 following a survey of 3.892 beneficiaries in 26 states, excluding the Federal District.

Graph 1 sets out the income of the families surveyed. 60. 4% of the households had an income of up to 1 minimum salary, which demonstrates that the focus of the program was lower income families. Graph 2 demonstrates that, prior to the arrival of electricity, the energy basket of the population surveyed was composed of traditional energy sources, primarily coal and firewood (used by 64.1% of the households) with recurrent use of kerosene lanterns (55.6%) and gas-lamps (37.6%). This demonstrates the significant potential of electricity to substitute the various types of traditional sources used as well as the greater energy yield of electricity and its lower cost.

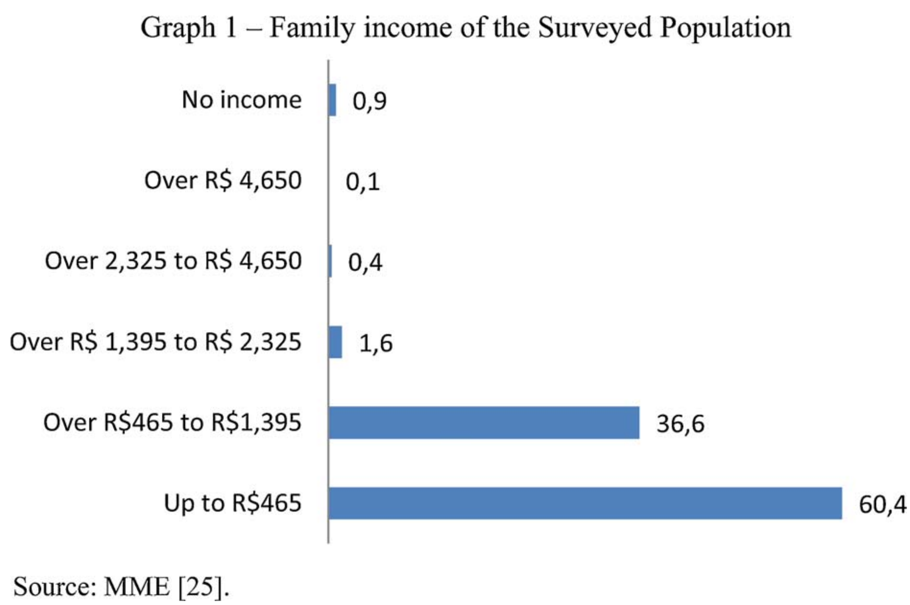
[23] The exchange rate in 2010 (February) was R$ 1.85 to US$ 1 [12].

**Table 11**
Summary of the evaluation.

| Country | Program | Period | Cost | Central objective of the program | Results of the program | Beneficiary |
|---|---|---|---|---|---|---|
| Brazil | "Light for all" | 2003–10 | US$ 9 billion | 12 million people | 11.4 million people | Low income population |

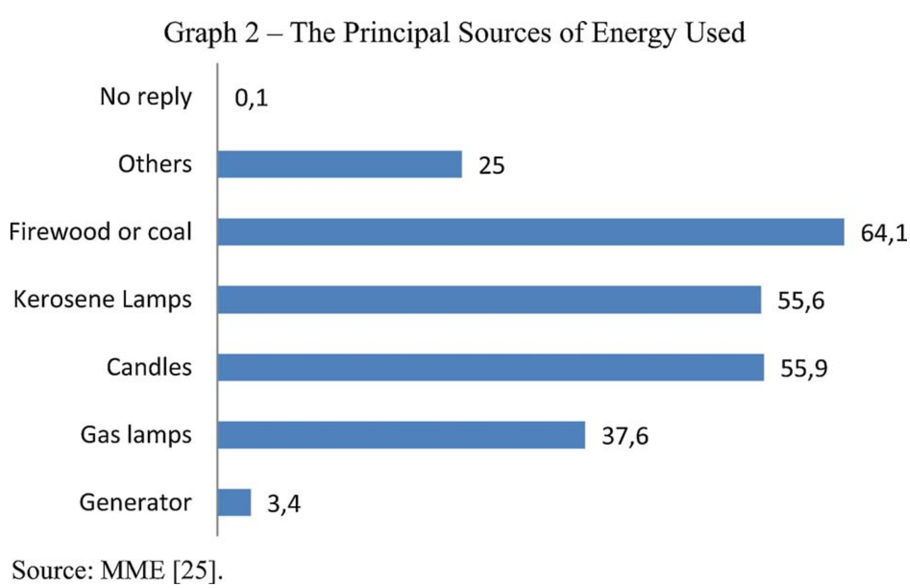
| Expected Result of the Evaluation | Methodology | Sample | Method of gathering information | Control | Context of the Evaluation | Results of the Evaluation |
|---|---|---|---|---|---|---|
| Evaluation of the impact on quality of life of the arrival of electricity | Ex-post | 3.892 beneficiaries | Not stated | Not used | The evaluation sought to adopt a multidisciplinary approach, highlighting the interviewee's perceptions | Improvement in the quality of life of the people, as a result, principally, of access to information, acquisition of electric home appliances and a reduction in the cost of energy (substitution). Increase in participation in civil organizations. |

Source: Drawn up by the authors.



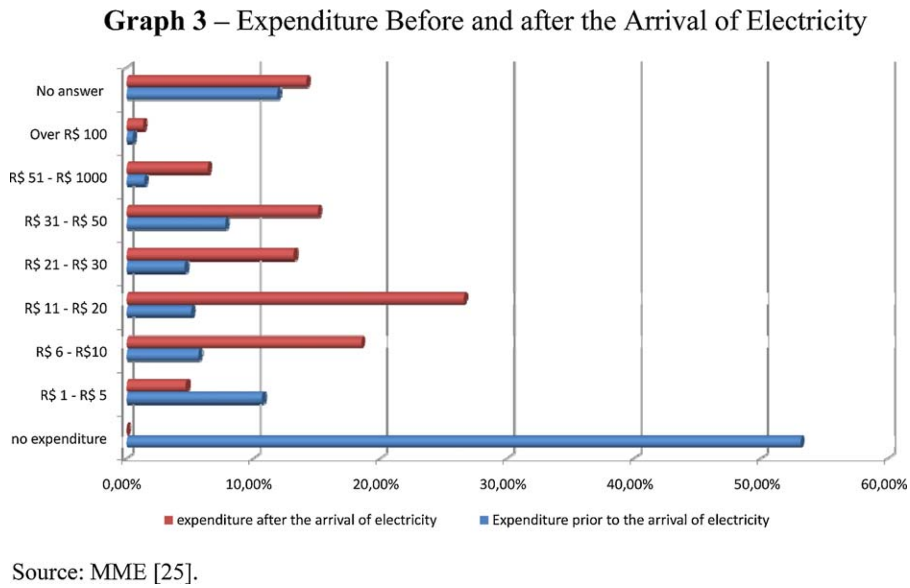

**Graph 1.** Family income of the surveyed population.

Source: MME [25].




**Graph 2.** The principal sources of energy used.

Source: MME [25].




**Graph 3.** Expenditure before and after the arrival of electricity.

Source: MME [25].

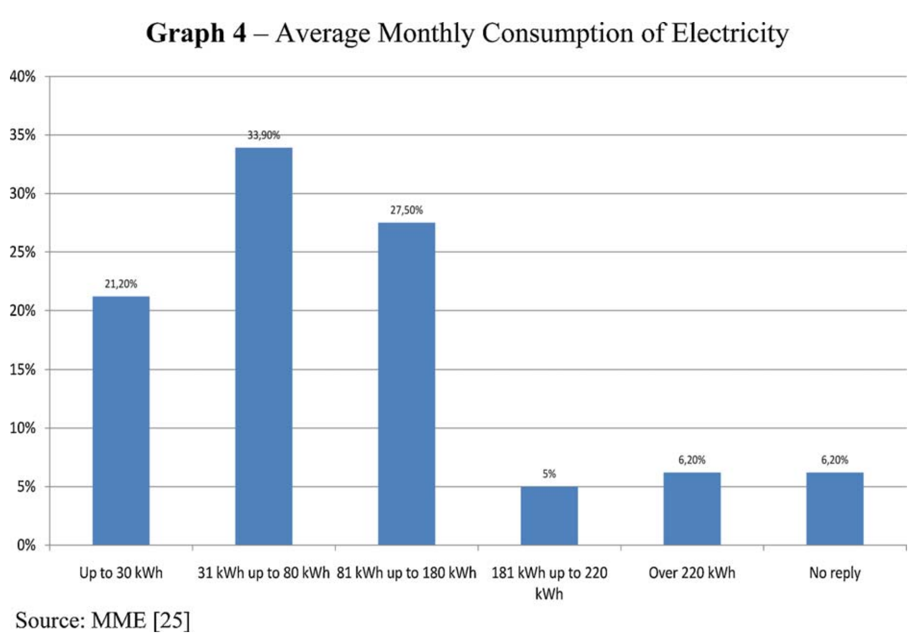
The expenditures devoted to energy consumption is shown on Graph 3, where it is highlighted that even that part of population that did not have access to electricity on a regular basis spent money on other energy sources (diesel, kerosene, gas or batteries). Latter on when that population begin to have access to electricity, 53.1% of the sampled population did not have spent on their energy budget.

Note that electricity rapidly established itself in the composition of the energy basket after the implementation of the Universalization Program, with 72.6% of the households surveyed consuming over 30kWh/month, with 11.2% of such households consuming for productive purposes (Graph 4).

The fact that electricity rapidly took hold is corroborated by Graph 5 which sets out in percentage terms the acquisition of electric home appliances following the arrival of electricity in the households surveyed, principally appliances related to information, entertainment, refrigeration, and water-pumps, such as, for example: TV (79.3%), hi-fi (sound systems) (45.4%), computers (2.5%), refrigerators (73.3%), freezers (16%) and water-pumps (24%).

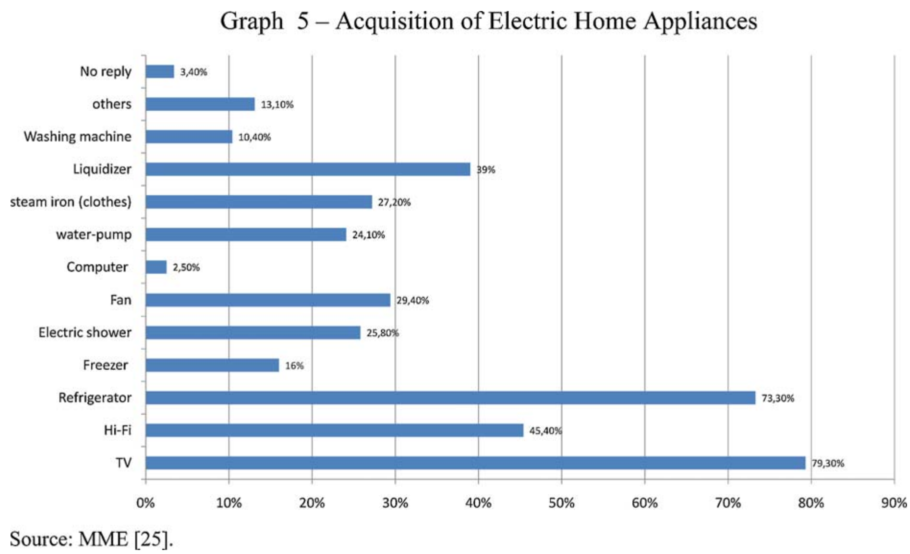
Refrigerators have particular significance in terms of social status for the population previously denied access to electricity on a regular basis. It is not unusual for people to acquire a refrigerator even prior to being connected to the electricity grid, in eager anticipation of the benefits of a less arduous life to be provided by the technology of the modern world.

The arrival of electricity gives rise to innumerable gains – both tangible and intangible, some ascertainable in monetary terms, others not. One of the principal benefits the local population reported to the researchers Pereira and Sena [26], during primary information gathering in the Northern Region (State of Acre – Amazonia) was "*being able to drink a glass of cold water*", a significant devel-



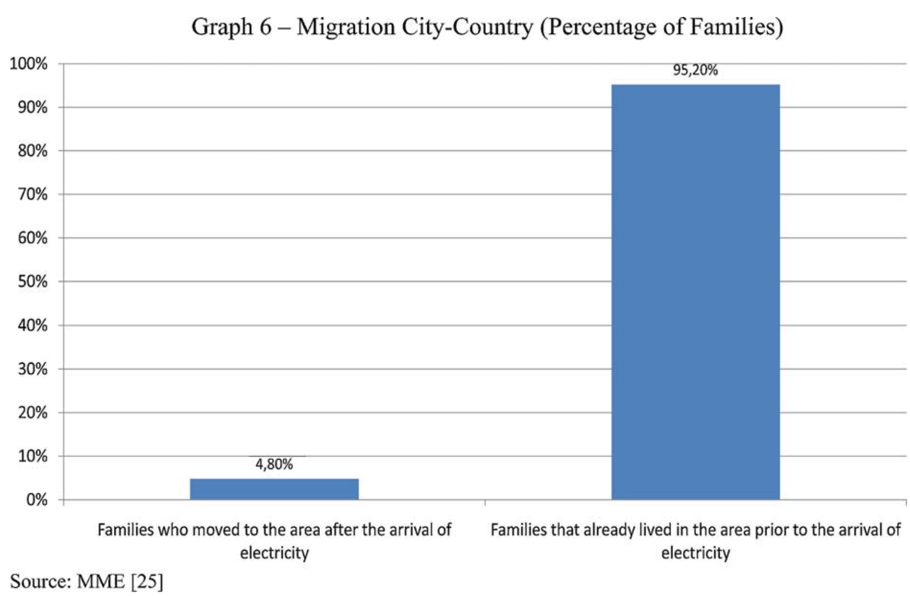

**Graph 4.** Average monthly consumption of electricity.

Source: MME [25].




**Graph 5.** Acquisition of electric home appliances.

Source: MME [25].




**Graph 6.** Migration city-country (percentage of families).

Source: MME [25].

opment in local terms that should not be underestimated. A less arduous life in the countryside opens up the possibility of reversing the trend of country to city migration. According to the MME [25], 4.9% of the families interviewed were returnees to the countryside. (Graph 6). This percentage, extrapolated to the country as a whole, would amount to 480,000 people leaving.

In spite of the major efforts to provide universal access to electricity, which has already benefitted 11 million people, the main challenge now, as stated by Pereira et al. [27] is to electrify the Amazon region, particularly isolated communities. Further strategies need to be adopted to this end, involving, of necessity, communication and cooperation between decision makers, the local population, concessionaires, the regulatory agency, universities and research centers so as to develop and fine-tune sustainable technologies as well as the establishment of a management model taking into account economic, environmental and cultural issues in the use of new technologies for renewable, de-centralized or individual generation, particularly photovoltaic. Such an approach would considerably accelerate the process of universalization.

## 5. Conclusion

Despite the existence of a large number of actions directed towards rural electrification in developing countries, few studies have been published setting out empirical evaluation of the impact of the provisions of electricity in terms of the promotion of sustainable development [28]. According to the IPEA/BIB [1], although efforts to this end have increased in recent years, insufficient importance is attached to an evaluation which begins at the initial design and formulation stage of the project and continues throughout implementation and thereafter. Rather, evaluation and monitoring are all too frequently relegated to a secondary and insufficiently influential role, with a trade off between the quality of the evaluation and the resources available. There is little justification for this,

particularly in the light of a survey of eight projects undertaken by the World Bank which indicated that the resources necessary for effective evaluation and monitoring amounted to between 0.2% and 1.26% of the total cost [18].

The access by disadvantaged populations to modern and renewable sources of energy is one of the main issues in the field of sustainable development. In spite of the many benefits of rural electrification, both qualitative and quantitative, as described above, electrification does not in itself entirely resolve the issue of energy use by very poor populations in rural areas who frequently resort to other fuel sources, especially firewood, to meet their energy needs, particularly for cooking, even when electricity is available. This can be seen from the data set out above relating to China and India where the population is still highly dependent on biomass to meet energy needs. Even though there is generally less dependence on biomass in Brazil there is a clear need in all the countries studied for action in conjunction with and beyond efforts to amplify access to electricity, directed towards technical improvement of wood ovens, with a view to ensuring that they operate in a cleaner and more efficient manner thereby reducing local emissions and degradation of the environment.

Another important issue to be addressed is that related to energy efficiency both in terms of the consumption of energy by the local population and the equipment used in the expansion of access. One of the major challenges facing both the Brazilian and Chinese governments is expanding access to remote rural areas (the north and north-eastern regions in Brazil and the western region in China). The general pattern is for energy to be supplied to these areas by solar panels or a hybrid system of panels plus diesel generators. Further public authority action in this direction is likely to enable the local population to acquire electric home appliances that contribute significantly to an improvement in their quality of life as well as improving their work-leisure balance, by making it possible to make optimum use of lighting for reading at night, of the TV for access to information, etc.

The degree of reliability of the service is one of the major concerns in the field of rural electrification, given that the benefits of access to electricity are considerably limited when subject to interruption in the supply or failure of the photovoltaic panel. In India, where blackouts are recurrent, the unreliability of the system leads to the continued use of kerosene. The incorporation into universalization projects (in all countries) of efficiency measures may significantly contribute to guaranteeing reliable uninterrupted supply, with a view (eventually) to the definitive substitution of the use of candles, batteries and kerosene. As seen above, the current unreliability of the systems in South Africa, China and India has meant that electricity in effect becomes only one in a range of energy options used by the population, which limits its capacity to engender improvement in living standards.

The expansion of electricity provision in rural areas has, in recent years, been a vector for the economic and social development of populations previously excluded form the energy matrix. The process of evaluation of the impact of public investment in the social area is fundamental in providing accurate and constructive feedback enabling those responsible for policy, planning and implementation to fine tune their efforts to achieve more sustainable development, reduce inequality and improve the living standards of rural populations. Evaluation of the effectiveness of public policy on rural electrification enables such policy to be re-considered, where necessary, so as to reinforce the sustainability of the planning and implementation stages and also to bolster the role that electricity plays in relation to other aspects of development and improvement in living standards.

Evaluation which is limited to merely recording the percentage figures on compliance with physical or financial targets is not an adequate assessment of the program in question. An effective evaluation requires that the results and the processes by which they were obtained be seen and accurately interpreted alongside the real changes that the program engenders in the reality to which it is directed.

Efforts to universalize the supply of electricity are aimed at improving the quality of life of rural populations, with evaluations being a fundamental tool for providing information which is essential to the continuity of said actions from the point of view of public policy, enabling government entities and other bodies to interact effectively so as to accelerate and expand the benefits to the target populations, thereby complying with their ethical duty of promoting the social and ethical inclusion of the disadvantaged target groups.

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